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NEW TYPES OF RADIATION-RESISTANT GLASS AND THEIR APPLICATION AREAS

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A series of radiation (paramagnetic and optical)-resistant oxide glasses have been developed. Certain areas of their application are specified.

The development of new types of vitreous materials is an important scientific and engineering problem. Glasses are structural components of measuring systems, sensors, optical instruments, etc., used in space satellites, spacecraft, and orbital complexes. The equipment and structural optical elements in spacecraft operate under conditions of radiation, and as these objects recede from the Earth, the space radiation becomes more intense.

Glasses resistant to radiation are needed for stable functioning of the systems used in spacecrafts. For example, in supersensitive high-precision magnetic measurements performed on board a spacecraft, stringent requirements with respect to enhanced radiation-magnetic (diamagnetic, paramagnetic) stability are placed on the glass. This class of glasses is arbitrarily called radiation-paramagnetic resistant (RPR), since paramagnetism as a rule is induced in diamagnetic and paramagnetic glasses. In optical measurements or in using glass as a transparent optical medium, requirements for preserving radiation-optical resistance (ROR) are imposed upon glasses.

Considering the variety of glasses used in space technologies and their service conditions, in addition to radiation resistance (RPR and ROR) glasses should possess other prescribed properties, for instance, a low level of dielectric loss in specified electromagnetic wave ranges, enhanced heat stability, a certain TCLE, etc., that is, possess a set of necessary properties.

The importance of developing glasses with prescribed properties can be demonstrated on the example of a protective coating for the photoelectric solar energy transducer which is the power source for the orbital space complex. The requirements include high transparency of the glass in the ultraviolet spectrum range, ROR, and radiation resistance to emergence and accumulation of charges on the glass surface and inside the glass volume. Otherwise, this could cause microdischarges and mechanical destruction of the glass.

The author offers for implementation a series of developed technologies:

RPR glass with insignificant dielectric loss in the superhigh frequency range of electromagnetic radiation (tangent of dielectric loss angle 25×10^{-4} with wavelength ≈ 3 cm).

RPR glass, opaque in the visible spectrum range (with glass thickness 1 mm);

a method for producing RPR vitreous ceramics with increased heat resistance ($\leq 400°C$);

a method for producing ROR glass blanks for making fiber optical light guides;

ROR glass with ultralow temperatures of deformation onset ($\approx 180 - 300°C$);

a method for producing thermochromic (thermosensitive) glass; for multiple used of this glass a decolorization method has been developed.

a method for radiation dosimetry using a fiberglass optical light guide;

Author's certificates have been issued for all the listed technologies.

Alongwith the above specified glasses, other RPR glasses have been developed as well: glasses with TCLE $(40 - 50) \times 10^{-7}\,°C^{-1}$; with a constant light transmission value in the visible and near-infrared spectrum regions ($\approx 400 - 1600$ nm), etc. Some types of RPR glasses are at the same time ROR; the same can be said of ROR glasses. Assigning a particular glass to the RPR or ROR category is arbitrary and determined by the specific conditions of the practical application of glasses. For the mentioned radiation-resistant glasses, a radiation-chemical output of $\leq 10^{-7}$ is guaranteed.

Application areas of the described glasses can be various. The glasses can be used not only in space technology, but in the nuclear power industry, radiochemistry, solid state physics, etc. These glasses, for example, can be used to make radiation-resistant ampoules for storing radioactive chemicals or to study objects which have been subjected to the ef-

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fect of radiation. Using a fiberglass light guide, it is possible to monitor the state of a system with a radioactive power source, the active zone of a nuclear reactor, etc. Such glass can be used as radiation-resistant coatings for low-melting materials and radioelectronic elements, for the protection of light-sensitive materials from the effect of ultraviolet and visible light, as well as an optical window, i.e., a light filter preserving color characteristics under the effect of radiation.

Based on optical glass light guides, acoustic, magnetic, and temperature sensors for measuring pressure, velocity, etc. are developed, which are used in various sectors of industry, including the defense industry [1]. Optical glass fibers are used to transfer an informational signal via a light guide, and they replace metal cables. Whereas electric circuits on metal cables are sensitive to electromagnetic noises, fiberglass optical lines do not have this drawback. The main obstacle for reliable functioning of systems based on optical light guides is their sensitivity to radiation. However, it is possible to increase the reliability of such systems using radiation-resistant light guides.

Prior to the development of the specified glasses, the paramagnetic, optical, and other properties of oxide (silicate, borate, phosphate) glasses were studied. These studies show the effect of simultaneous prevention of formation of electron and hole centers induced in glass by radiation [2], which lead to the possibility of obtaining glasses with high radiation resistance. Previous development of glasses (mostly ROR glasses) was based on the effect of preventing only the formation of the hole radiation center.

The author will be grateful to all specialists for advice concerning the further development of these glasses, the prospects of their use, and the specifications of these glasses, which will lead to further research and development and to mass production of these articles.

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